Wax

| THE ALOHA SYSTEM | Project: TCU Modem | CCG/G-43 | 21 pages |
|---|---|---|---|
| Title: TCU MODEM ALIGNMENT PROCEDURE | | General Document | |
| | | May 24, 1974 | |
| Author(s): David W. Wax | Checked: D.W. Wax | Approved: JJ Kuo | |

## INTRODUCTION

The purpose of this document is to provide adjustment procedures for the proper alignment of any ALOHA TCU modem. The reader is referred to the ALOHA SYSTEM general document number CCG/G-42 for information on the theory of operation of the modem. A schematic and timing waveforms are included as part of this document for reference purposes. Adjustments will be facilitated by use of the MODEM TEST PANEL. However, if this panel is not available, appropriate test signals and interconnections may be used as shown in the MODEM TEST PANEL drawing, number RF 1018.

## REQUIRED TEST EQUIPMENT

1. Oscilloscope, Storage: Hewlett-Packard model 181A or equivalent. (Equipped with dual trace plug-in and single sweep time base).
2. VTVM, True RMS: Ballantine model 323-07 or equivalent.
3. Noise Generator: Hewlett-Packard model 3722A or equivalent.
4. Digital Voltmeter: Hewlett-Packard model 970A or equivalent.
5. Variable Attenuator, 600 Ohm: Hewlett-Packard model 350D or equivalent.
6. Modem Test Panel: ALOHA drawing number RF 1018.
7. Data Simulator: ALOHA drawing number RF 1016.
8. Error Detector: ALOHA drawing number RF 1019.

## ALIGNMENT PROCEDURE

Mount the modem board to be tested onto the two hinged standoffs

located on the front of the Modem Test Panel. The panel's layout is shown in Fig. 1. After checking to see that the panel's power switch is off, connect the five volt power supply leads to the appropriate connectors on the modem board. Insert the test signal DIP connector into the proper position on the modem board (see Fig. 4 for location on modem board). Connect the six test-point leads from the test panel to the modem board pins as follows:

| Signal | Test Point | Modem Pin Number |
|---|---|---|
| Xmt Signal | A | FA19 |
| Rcv Signal | B | JB38 |
| Pre-emph. Signal | C | TA42 |
| Noisy Clock | D | FB14 |
| S/N Ph. Detect. Output | E | BB49 |
| S/N Integrator Output | F | GB23 |

Set test panel switches as follows:

LOCAL-REMOTE: LOCAL
BURST : OFF
RS : OFF
SDA : ZERO
MODEM : RADIO or 600Ω as appropriate

Turn on panel power. The modem board power supply current should read about one ampere. Should the current deviate more than 20 percent from this value, turn off the power and check the modem for shorts, incorrect wiring, or

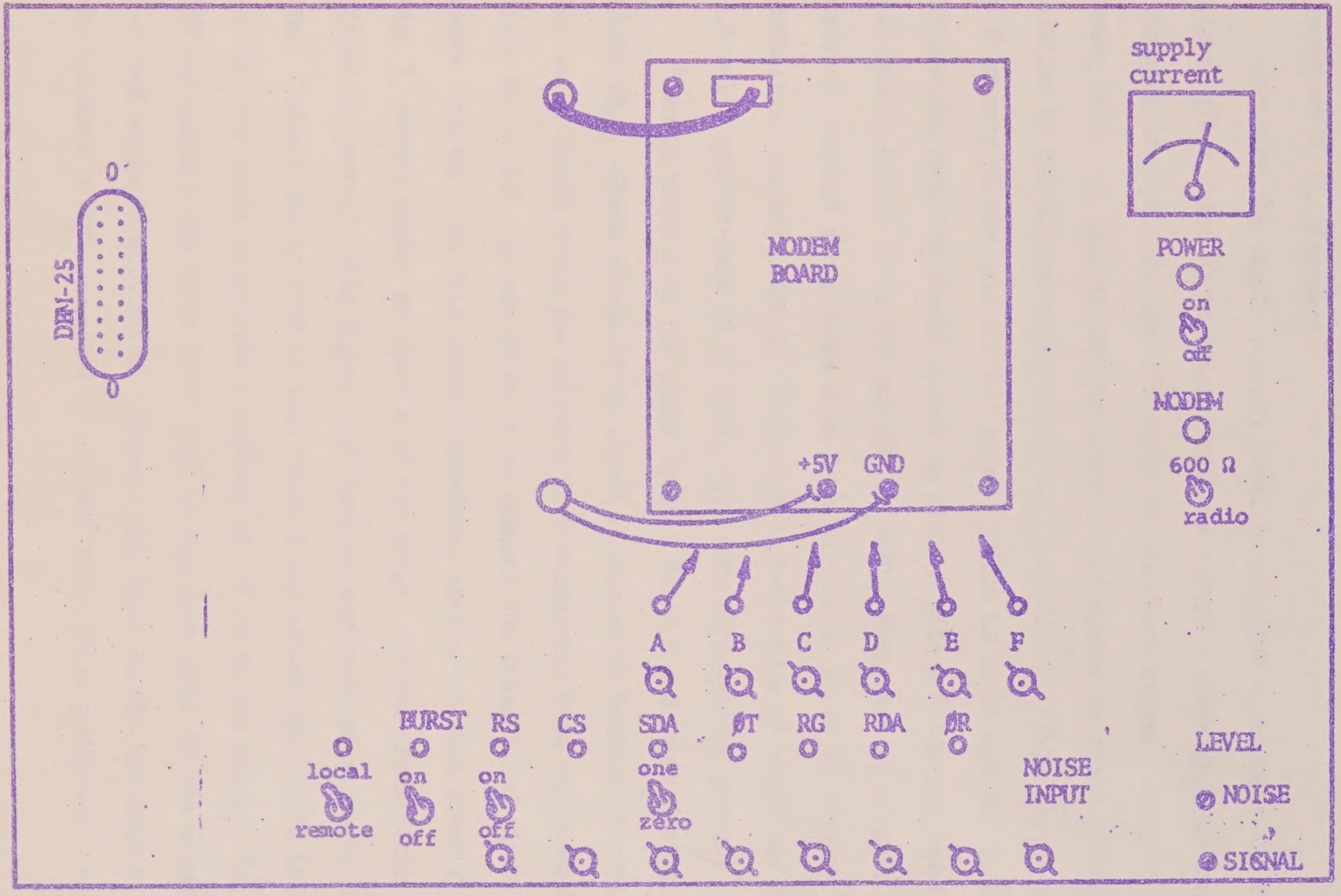
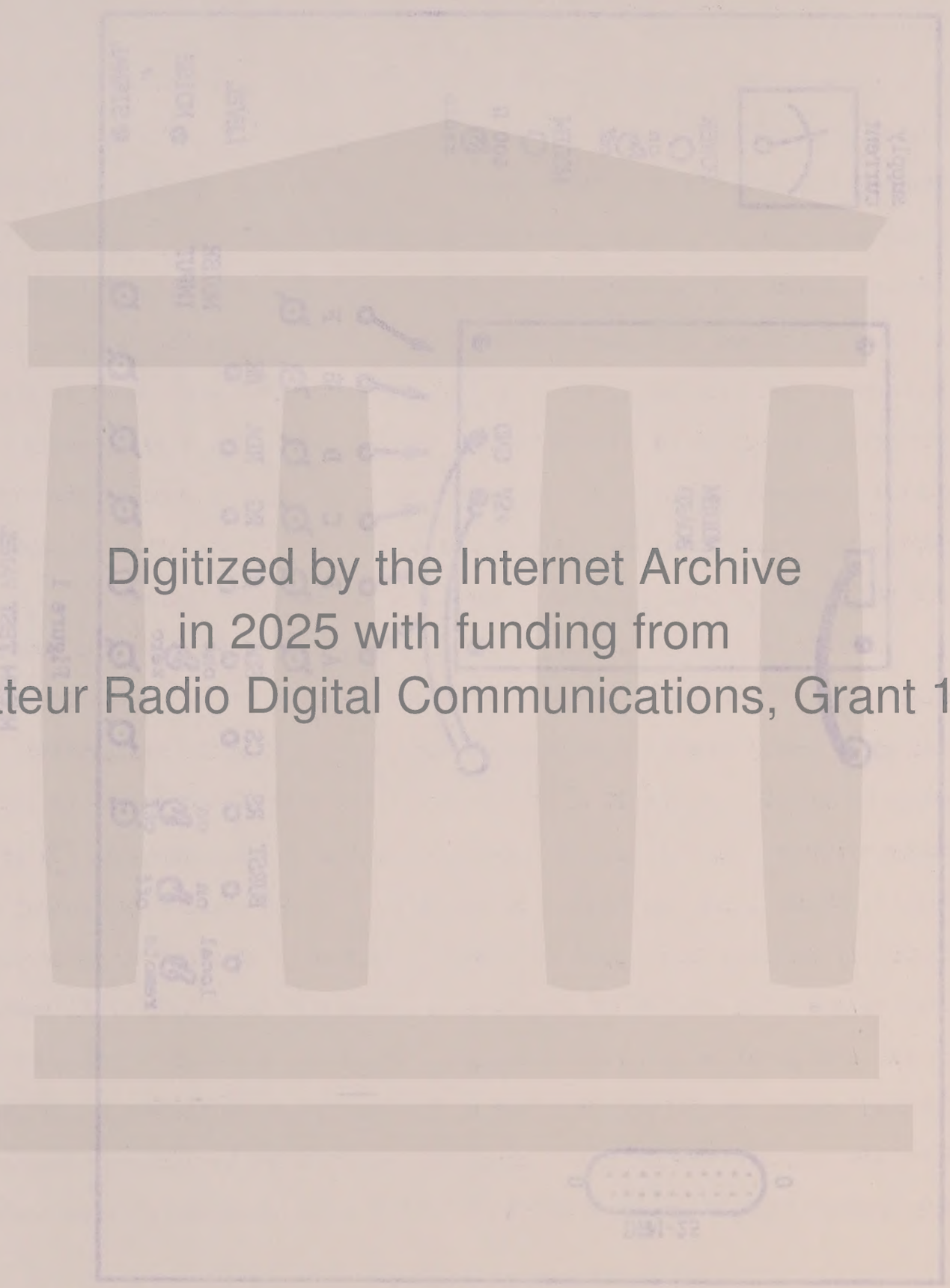



Figure 1

MODEM TEST PANEL



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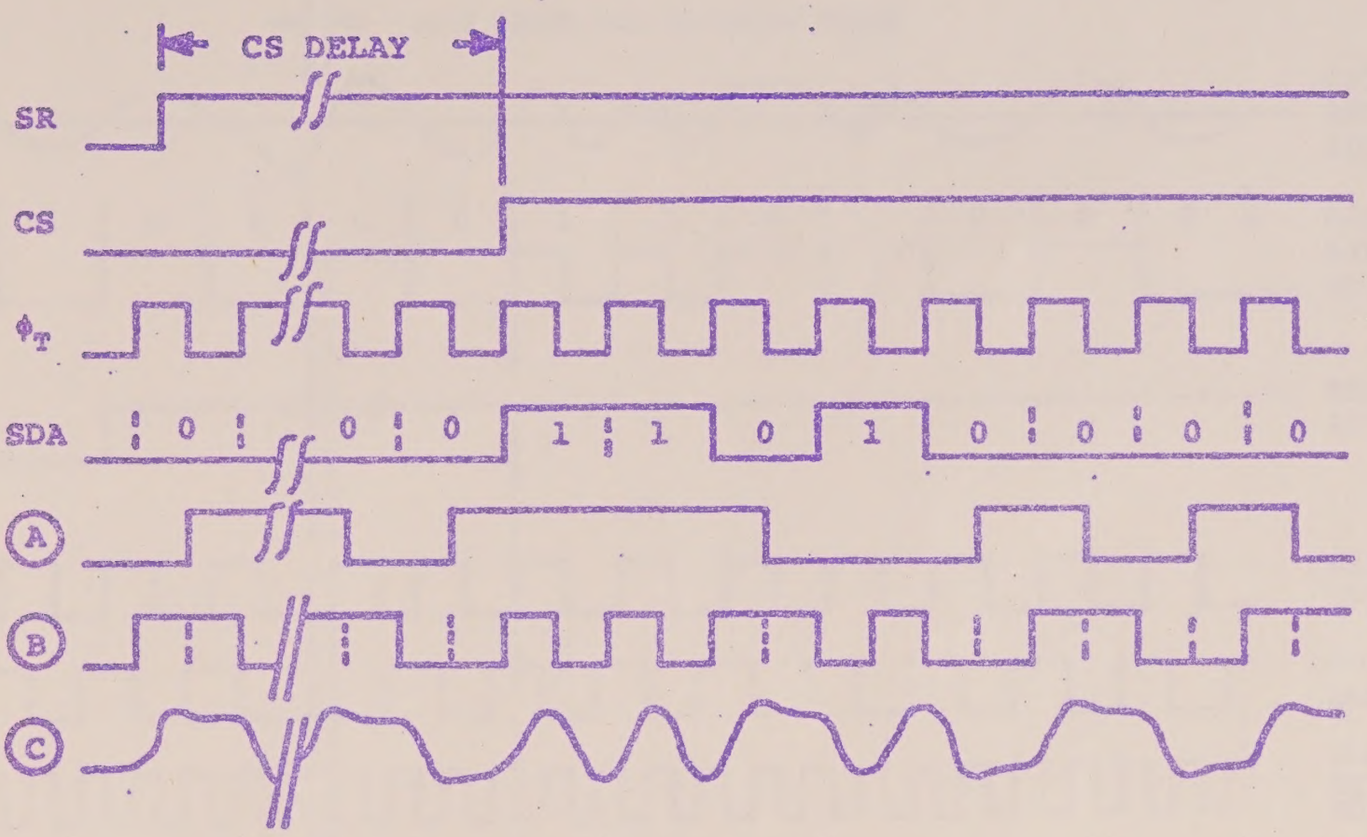
Amateur Radio Digital Communications, Grant 151

https://archive.org/details/aloha-18

incorrect I. C. placement.

Assuming the supply current level is acceptable, connect the transmit signal (Test Point A) to trace A and the transmit clock ($\emptyset_T$) to trace B of the oscilloscope. Trigger the scope on the clock signal, using the alternate sweep mode. An "all-zeroes" waveform should appear on trace A which is similar to the ZERO waveform shown in (C) of Fig. 2. This signal should have a frequency of one-half the bit rate. Switch RS to ON and SDA to ONE. A simusoidal waveform should appear on trace A with a frequency equal to the bit rate. Return RS to OFF and SDA to ZERO. When testing a radio modem version, connect scope trace A to Test Point C in order to display the pre-emphasized transmit signal. This signal should have an amplitude of about 0.8 volt, peak-to-peak (0.24 volt, rms) when transmitting zeroes.

Connect trace A of the scope to Test Point B and trace B to the receive clock ($\emptyset_R$). There should be no signal displayed on trace A (except for a low noise level) since the receiver is disconnected from the transmitter while RS is OFF. Switch RS to ON to connect the transmitted signal to the modem receiver. An "all-zeroes" waveform, similar to that shown in (D) of Fig. 3, should appear on trace A of the scope. If the transmitter output amplitude is correct, this signal will have an amplitude of about 50 millivolts, rms. Connect the ac VTVM to Test Point B and adjust the SIGNAL LEVEL control on the test panel to provide a reading of -24 dB on the meter. Switch RS to OFF and connect the NOISE INPUT jack of the test panel to the output of the H-P 350D variable attenuator. Connect the input of the variable attenuator to the VARIABLE OUTPUT connector of the H-P 3722A noise generator. Adjust controls



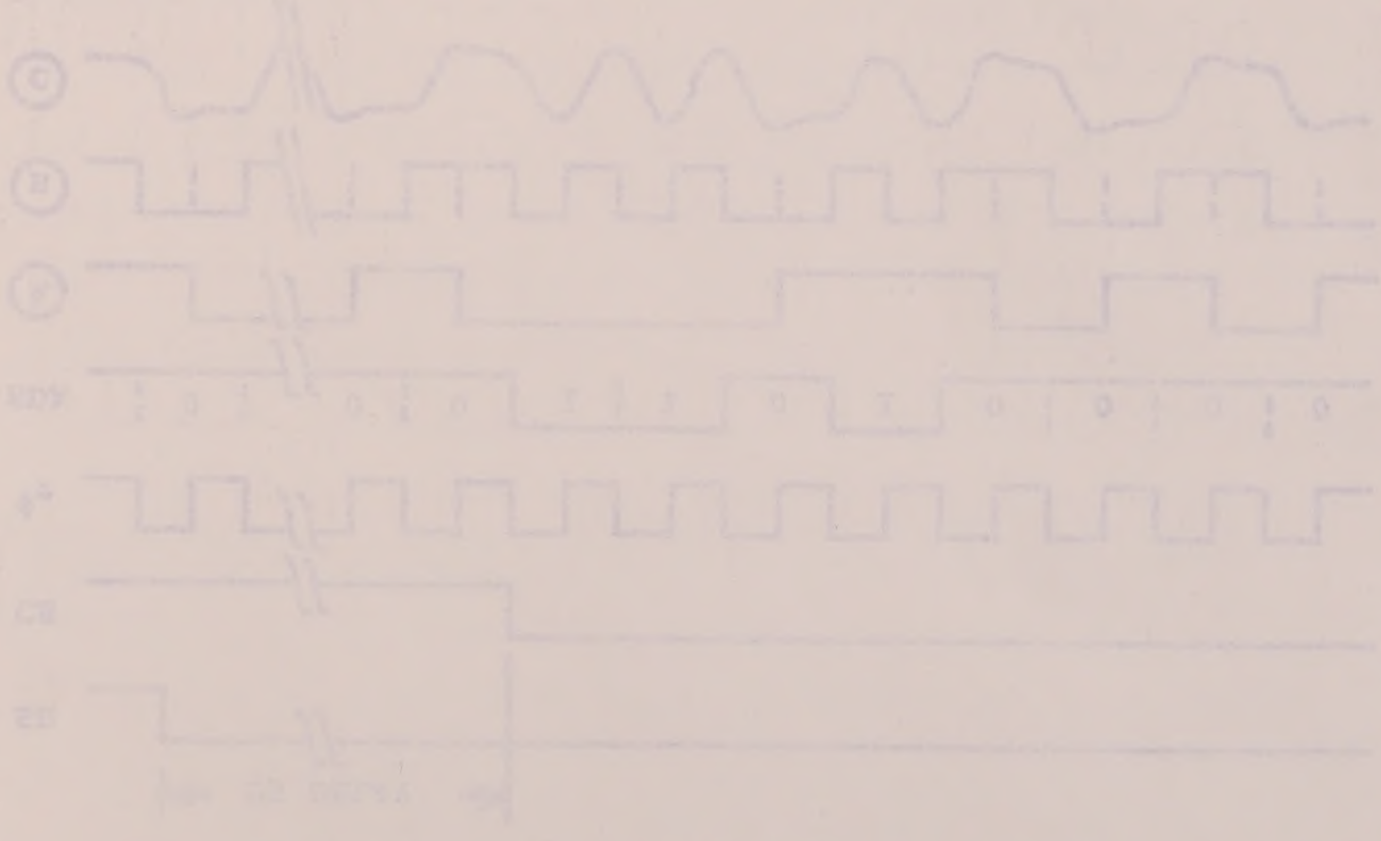

(A) - Differentially-Encoded Xmt. Data Signal

(B) - Differentially-Encoded Bi-phase Modulated Carrier

(C) - Filtered DBPSK Carrier

Figure 2

MODULATOR WAVEFORMS



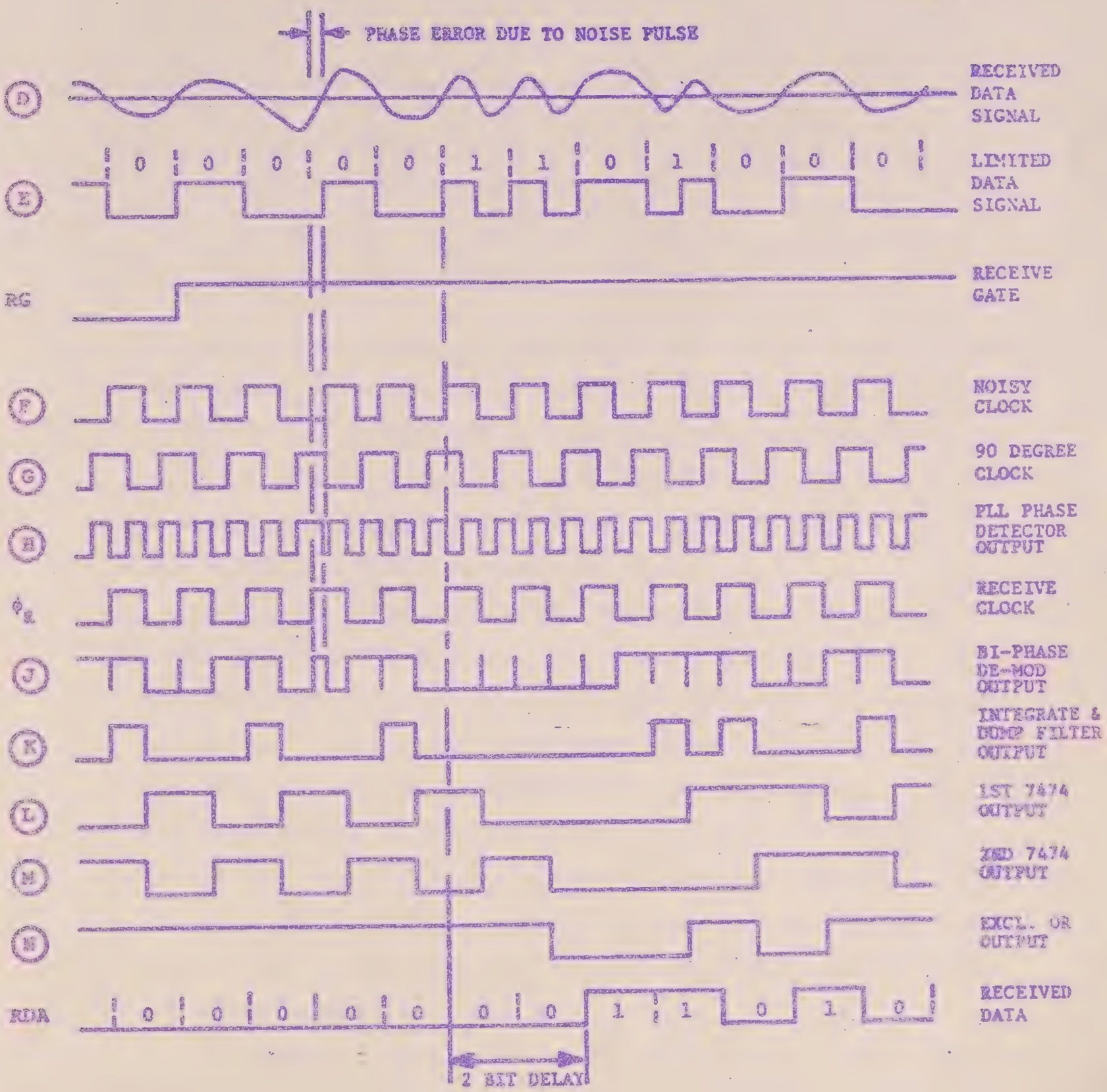



Figure 3

DEMODULATOR WAVEFORMS

on the noise generator as follows:

SEQUENCE LENGTH: INFINITE

GAUSSIAN NOISE BANDWIDTH: 50 KHZ

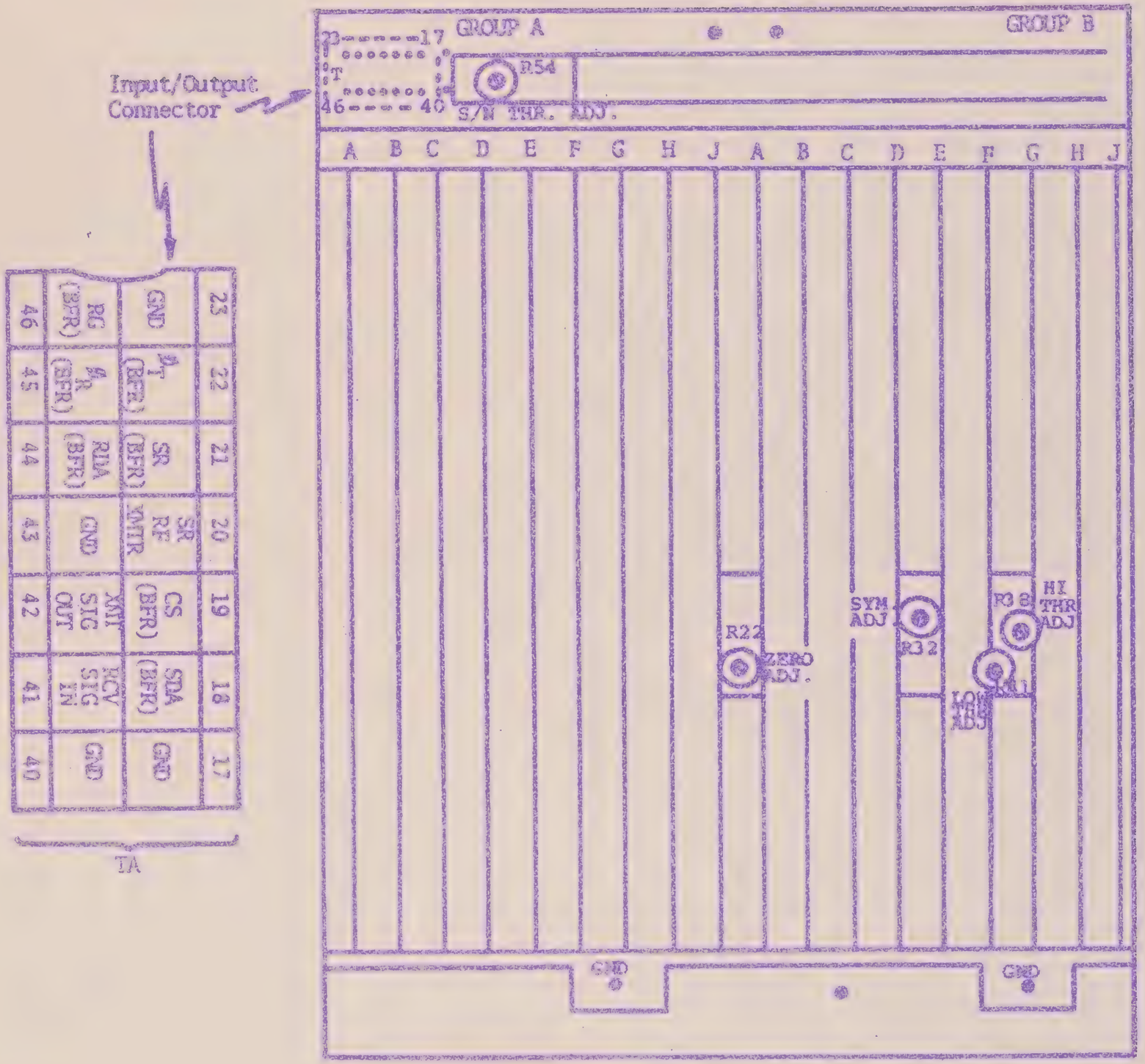
RMS AMPLITUDE: 1.0 × 3.16 Volts Gaussian

VARIABLE OUTPUT: GAUSSIAN

Set the HP 350D attenuator to 0 dB attenuation and push the RUN and LINE ON-OFF buttons of the noise generator. A noise signal amplitude should appear on the VTVM at about 50 millivolts, rms. Adjust the NOISE LEVEL control on the test panel so that the meter reads -24 dB. This procedure sets up the signal-to-noise reference levels. Set the attenuator to 60 dB attenuation to effectively remove the noise for the next set of tests.

Refer to Fig. 4 for the location of adjustment controls on the modem board. Place the probe of the digital voltmeter on pin number GB19 (output of 1st Limiter) and adjust R22, ZERO ADJUST, until the meter reads zero volts dc, ±5 millivolts. Place the meter probe on pin HB49 and adjust R38, HIGH THRESHOLD ADJUST, for a reading of 3.1 volts dc. Place the meter probe on pin HB44 and adjust R41, LOW THRESHOLD ADJUST, for a reading of 2.5 volts dc. To check loop error voltage, place the meter probe on pin HB45. The dc voltage reading should average about 2.8 volts dc. To ensure that internal noise of the modem does not affect this reading, turn the attenuator setting to 0 dB while making this reading.

After making the previous adjustments, switch RS to ON. Connect Test Point D to trace A of the scope and trigger on the noisy clock signal which is displayed. The noise attenuator should have been reset to 60 dB so that a stable noisy clock is obtained. Adjust R32, SYMMETRY ADJUST, to display a




Note:
For 600 ohm version, xmt. sig. out is on pins TA42 and TA43. Rcv. sig. in is on pins TA40 and TA41.

Figure 4

ADJUSTMENT LOCATIONS & I/O CONNECTIONS

symmetrical clock waveform. Connect Test Point E to trace A of the scope and trigger on trace B, the receive clock. Trace A now displays the output of the S/N phase detector which should appear as a constant ZERO level when the loop is properly locked onto the signal. However, because of imperfect waveform symmetry in the noisy clock and jitter in the recovered clock a series of vertical "spikes" will appear on this waveform at the phase reversal points of the compared waveforms. When the loop is optimally adjusted, the width of these spikes will be minimal. This width can be minimized by carefully adjusting the high and low threshold settings (R38 and R41). However, these threshold settings cannot be brought so close together as to cause excessive jitter of the recovered clock. Therefore, some practice will be required to get the "touch" of "fine-tuning" these two adjustments. A small adjustment of R32, SYMMETRY ADJUST, will help minimize the average width of these spikes. The S/N threshold may now be set, as follows.

Connect Test Point F, S/N Integrator Output, to trace A of the scope and RG to trace B. Connect RS to the external trigger input of the scope and adjust the scope's time base unit for external triggering on a positive slope. Adjust the vertical amplifier sensitivity on trace A to 1 volt/division for best accuracy. Check to ensure that the vertical amplifiers are properly calibrated. Set the time base for 0.5 seconds/division and place scope in storage mode so that the trace can be retained. Switch RS from OFF to ON and observe the dc voltage on trace A when RG goes from OFF to ON. Repeat this measurement while adjusting R54, S/N THRESHOLD ADJUST, until RG switches from OFF to ON when the S/N Integrator output reaches +3.7 volts dc. This completes

all the TCU modem adjustments.

The remaining test is to determine if the CS delay is correct. Connect RS to trace A and CS to trace B of the scope. Set the scope to trigger on trace A, positive slope. Set the scope in storage mode with time base at 1 milliseconds/division. Switch RS from OFF to ON and observe the time delay before CS changes from OFF to ON. The time delay should be 9 milliseconds, ±1 millisecond. If the delay is only 4 msec, the modem under test is an older version which was not modified and should be adjusted to a 9 msec. CS delay by changing C7 to 2.2 μF. This completes the normal modem alignment procedure, unless an error-rate measurement is determined to be required.

ERROR RATE TEST

This is an optional test which is usually performed to see if the modem is operating properly. It need only be performed when deemed advisable. Connect the ALOHA Data Simulator and the ALOHA Error Detector to the DBM connector on the Modem Test Panel through a special wye connecting adapter cable as shown in Fig. 5. Switch the LOCAL-REMOTE switch to REMOTE. Connect a 10 kilohm resistor from a +5 volt pin on the modem board to pin TA26. This will cause RG to stay ON continuously, even for low S/N ratios. Turn on the Data Simulator and Error Detector and set the switches on the Data Simulator to CONTINUOUS, ALOHA CLOCK, and RUN. On the Error Detector, set the count interval switch to $X10^4$ and press the reset button. The red SYNC light should come on and the count light should flash once every second (actually 0.96 second with the 9600 BIT/SEC modem). The digital readout will display the

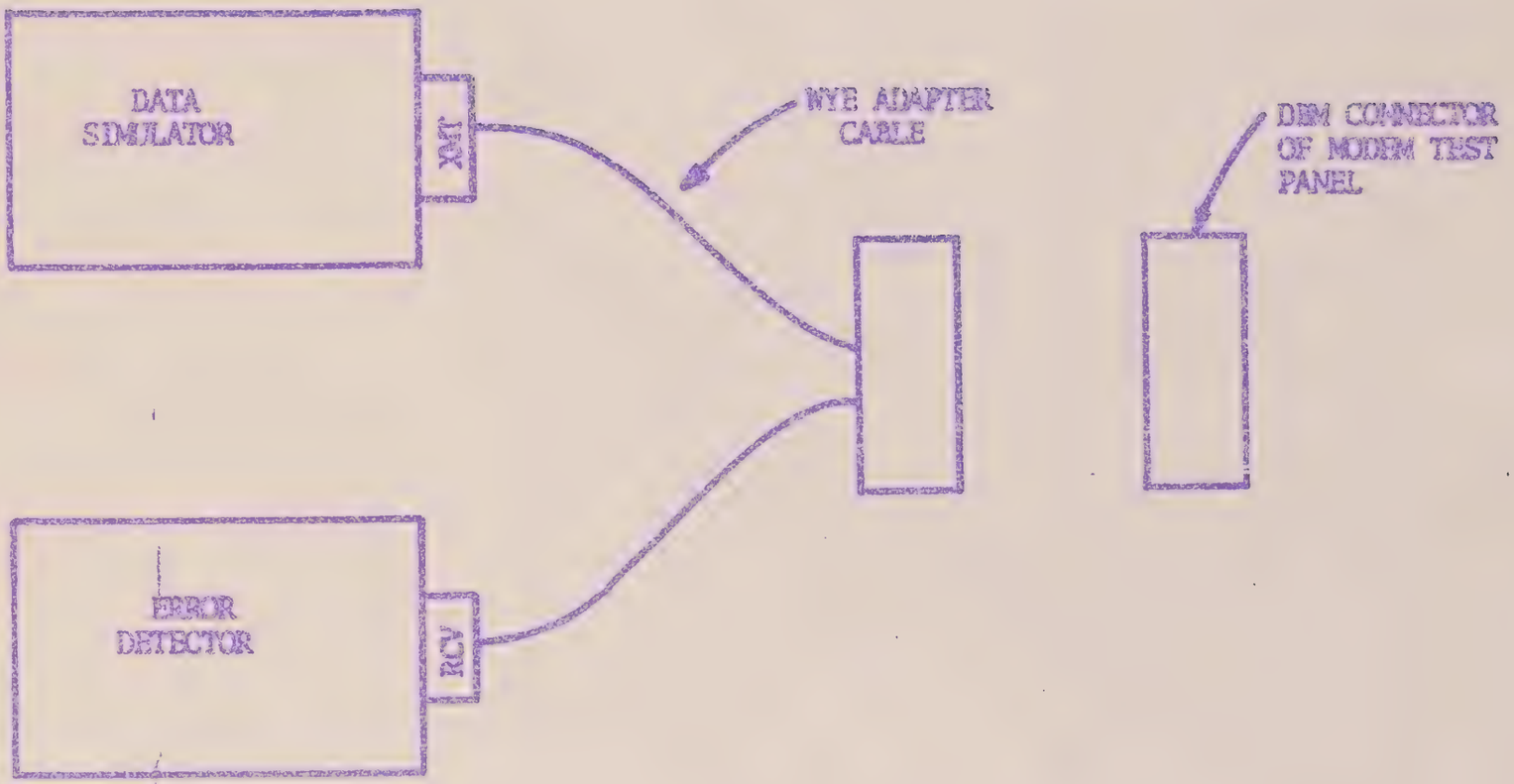



Figure 5

ERROR RATE TEST SET-UP

number of bits in error in $10^4$ bits. Since the noise attenuator is set at 60 dB, there should be zero errors indicated. The setting of the noise attenuator provides a direct reading of the signal-to-noise ratio in dB. Thus, a 0 dB setting corresponds to a 0 dB S/N ratio. Starting at about 3 or 4 dB S/N ratio (or whatever ratio at which sync can be maintained), measure the bit error rate for each increment of one dB. Several readings at each setting should be observed and the average reading recorded (usually 10 readings will be adequate). When a S/N ratio of 8 or 9 dB is reached, the Error Detector count interval switch should be changed to $X10^5$ to obtain better resolution of the measurement. Each count takes 9.6 seconds at this setting, so no more than 10 readings for each S/N ratio setting should be taken in order to save time. The measurements should be made for S/N ratios up to 13 dB. The data taken will be used to construct a plot of error probability versus S/N ratio. The measured error rate should approximate the curve shown in Fig. 6.

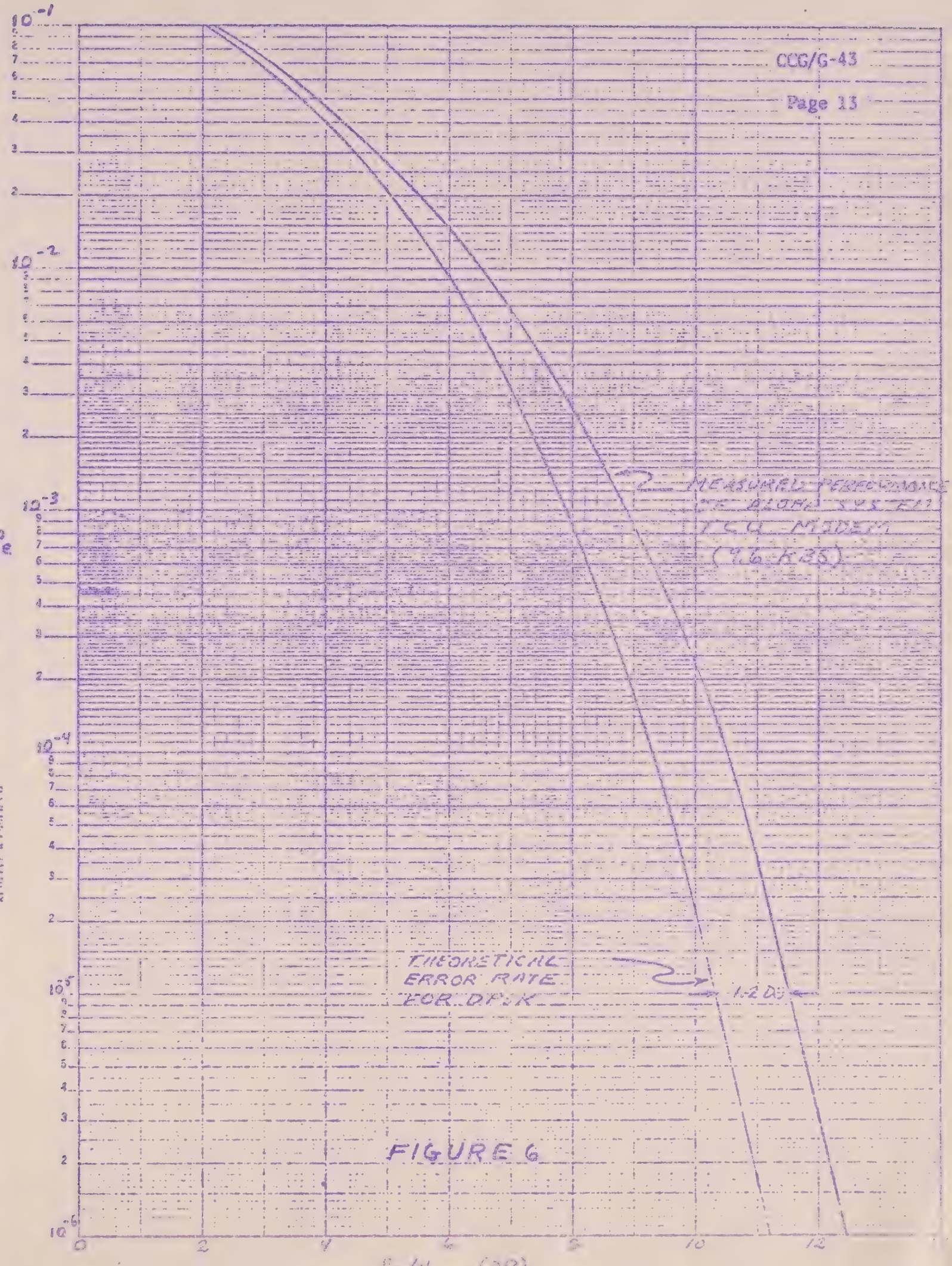
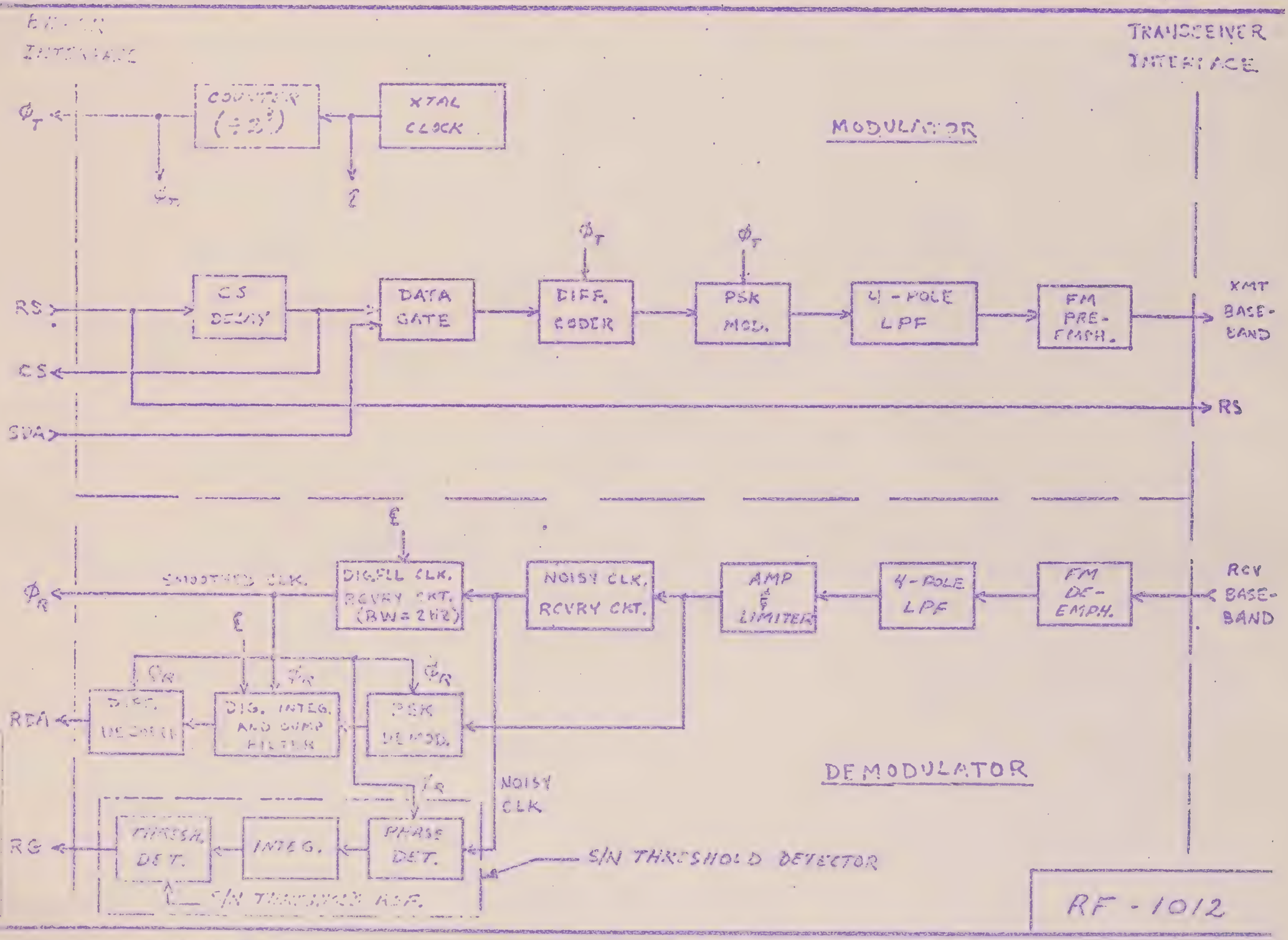
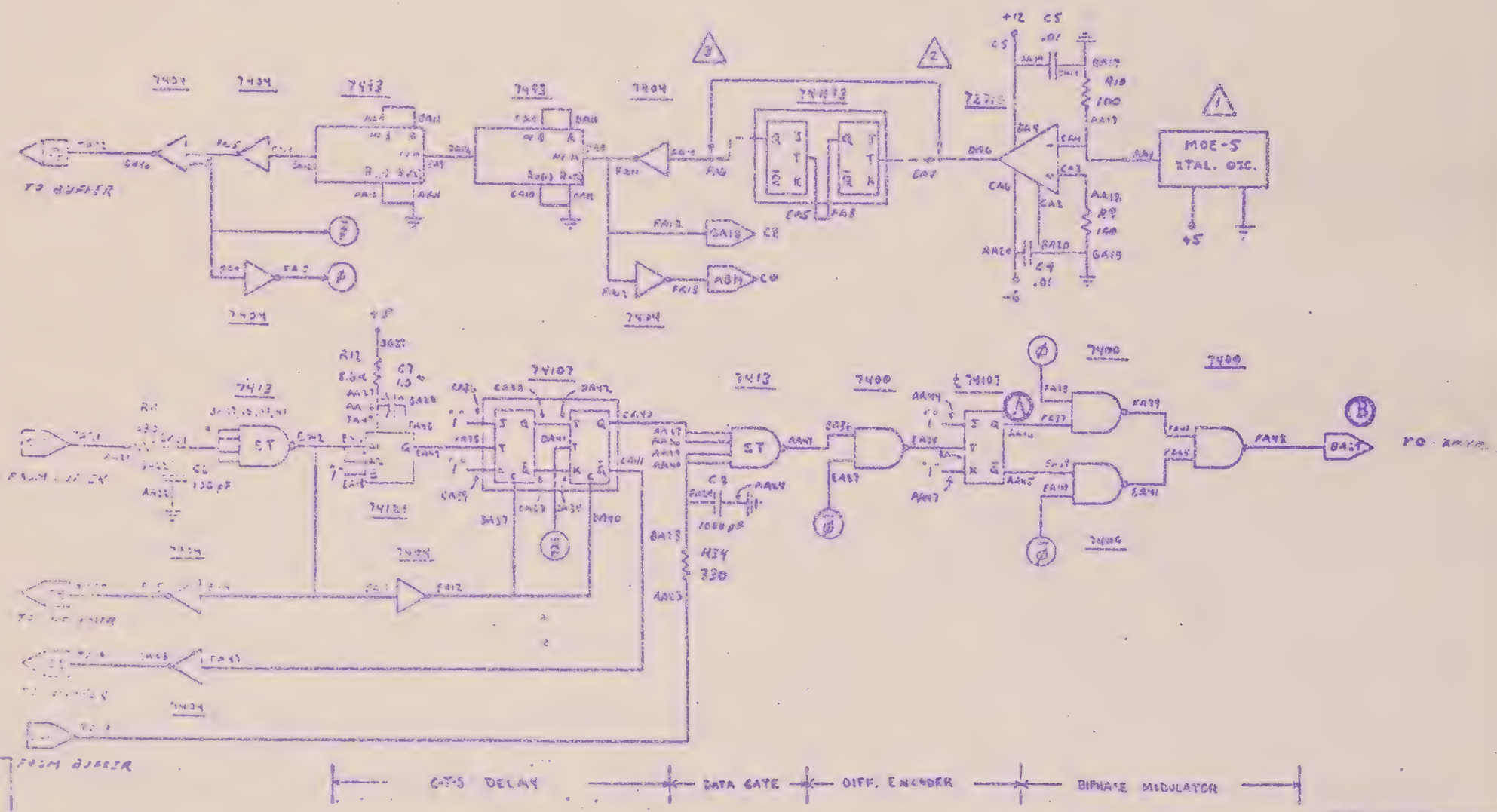

$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$P_e$
MEASURED PERFORMANCE OF GLOBAL SYSTEM ICC MODEM (9.6 K 25)
THEORETICAL ERROR RATE FOR DPSK
1.2 DB
0
2
4
6
8
10
12
$E_b/N_o$ (DB)

FIGURE 6


TRANSCEIVER INTERFACE
MODULATOR
COUNTER (÷2^3)
XTAL CLOCK
CS DELAY
DATA GATE
DIFF. CODER
PSK MOD.
4-POLE LPF
FM PRE-EMPH.
XMT BASE-BAND
RS
CS
SDA
DIG. FLL CLK. RCVRY CKT. (BW=2HZ)
SMOOTHED CLK.
NOISY CLK. RCVRY CKT.
AMP & LIMITER
4-POLE LPF
FM DE-EMPH.
RCV BASE-BAND
DIFF. DECODER
DIG. INTEG. AND DUMP FILTER
PSK DEMOD.
NOISY CLK
RDA
RG
THRESH. DET.
INTEG.
PHASE DET.
S/N THRESHOLD DETECTOR
S/N THRESHOLD REF.
DEMODULATOR
RF-1012

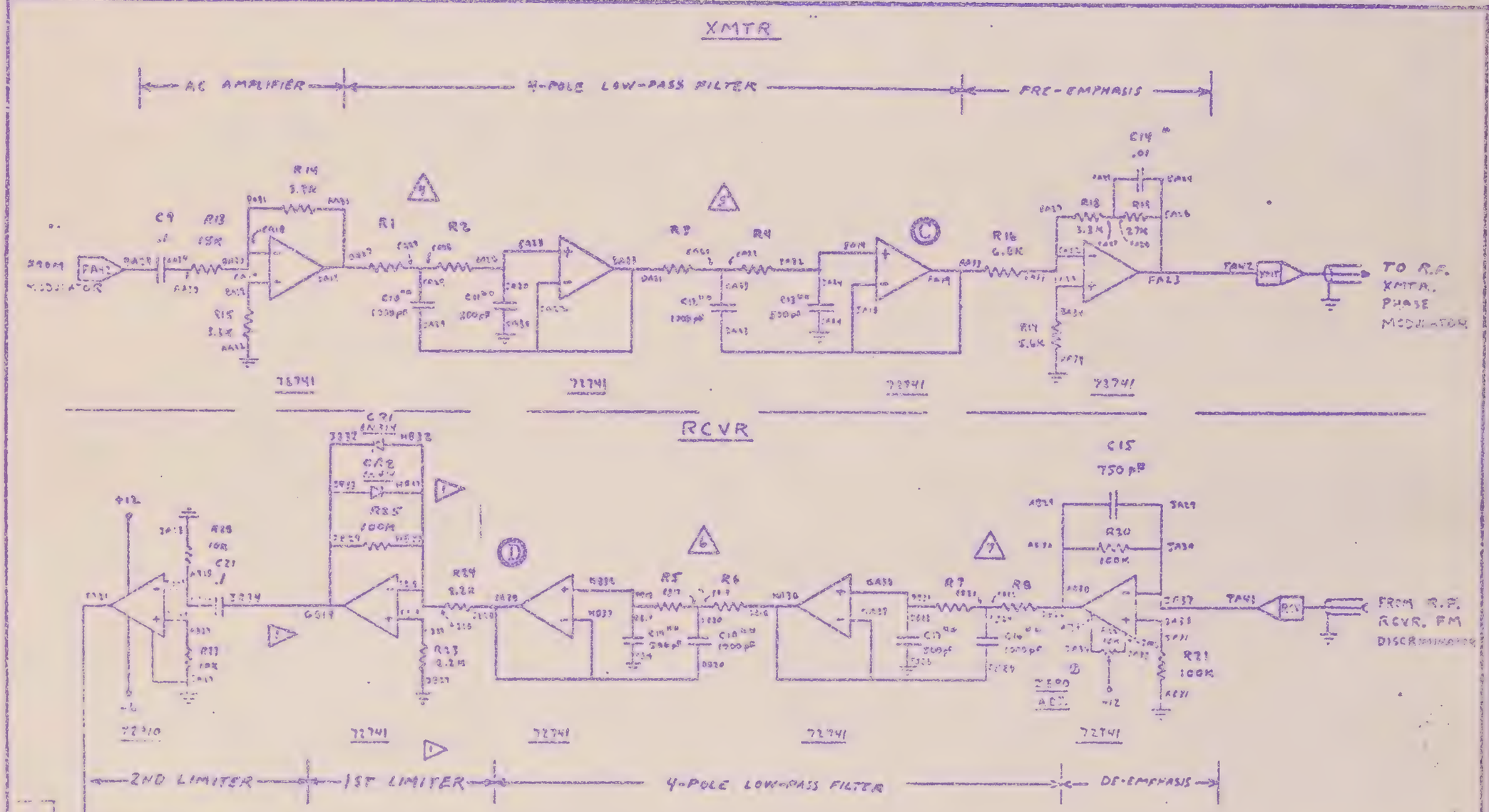



△ — SEE DATA RATE OPTION TABLE

* — 10 % TOLERANCE

RF1013-01

ALOHA System Project,
U. of H.
System: TCU MODEM
Sub-system: MODULATOR
Name D. Wax
Date 11-10-73
Page 1 of 1

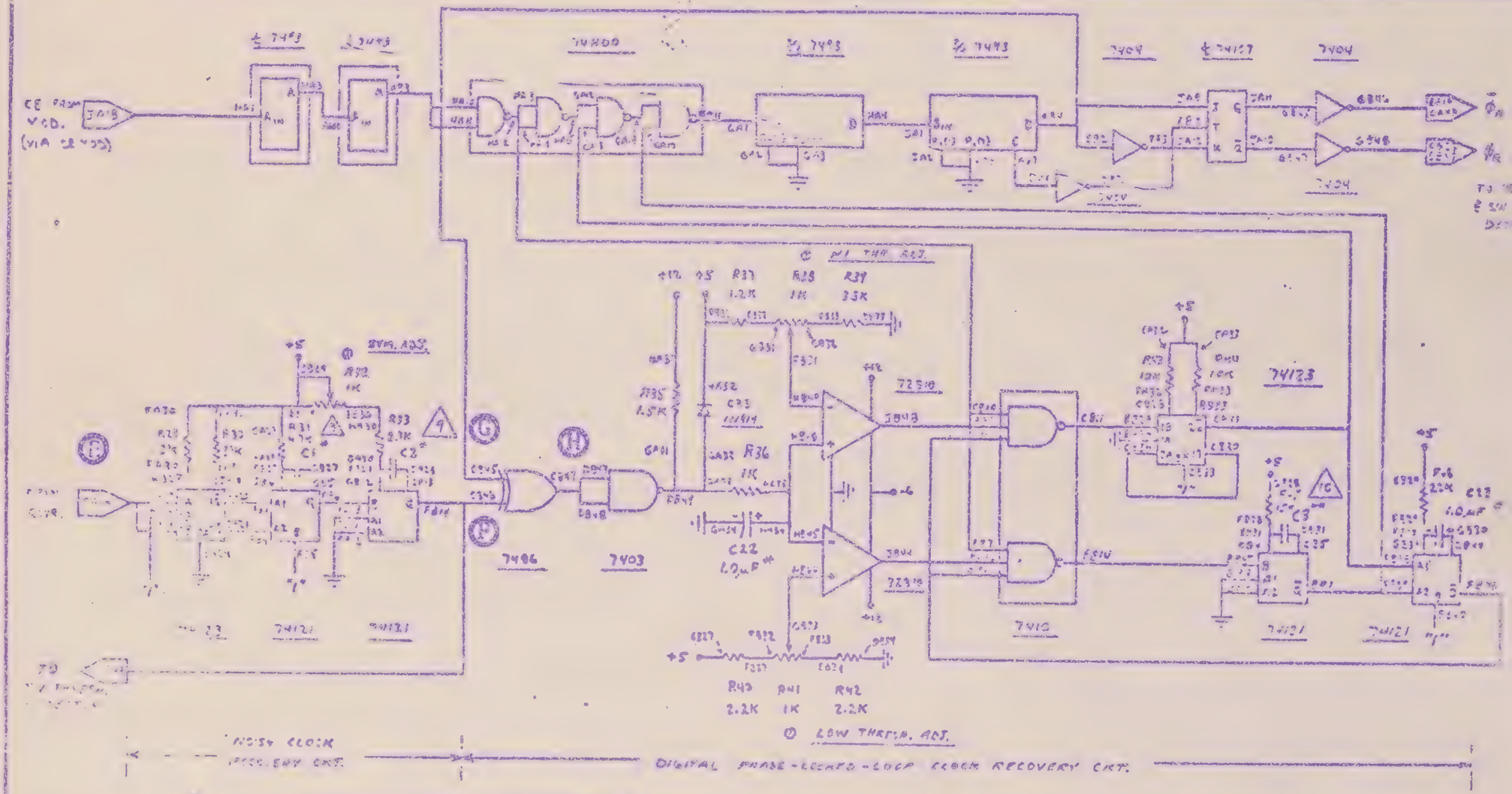


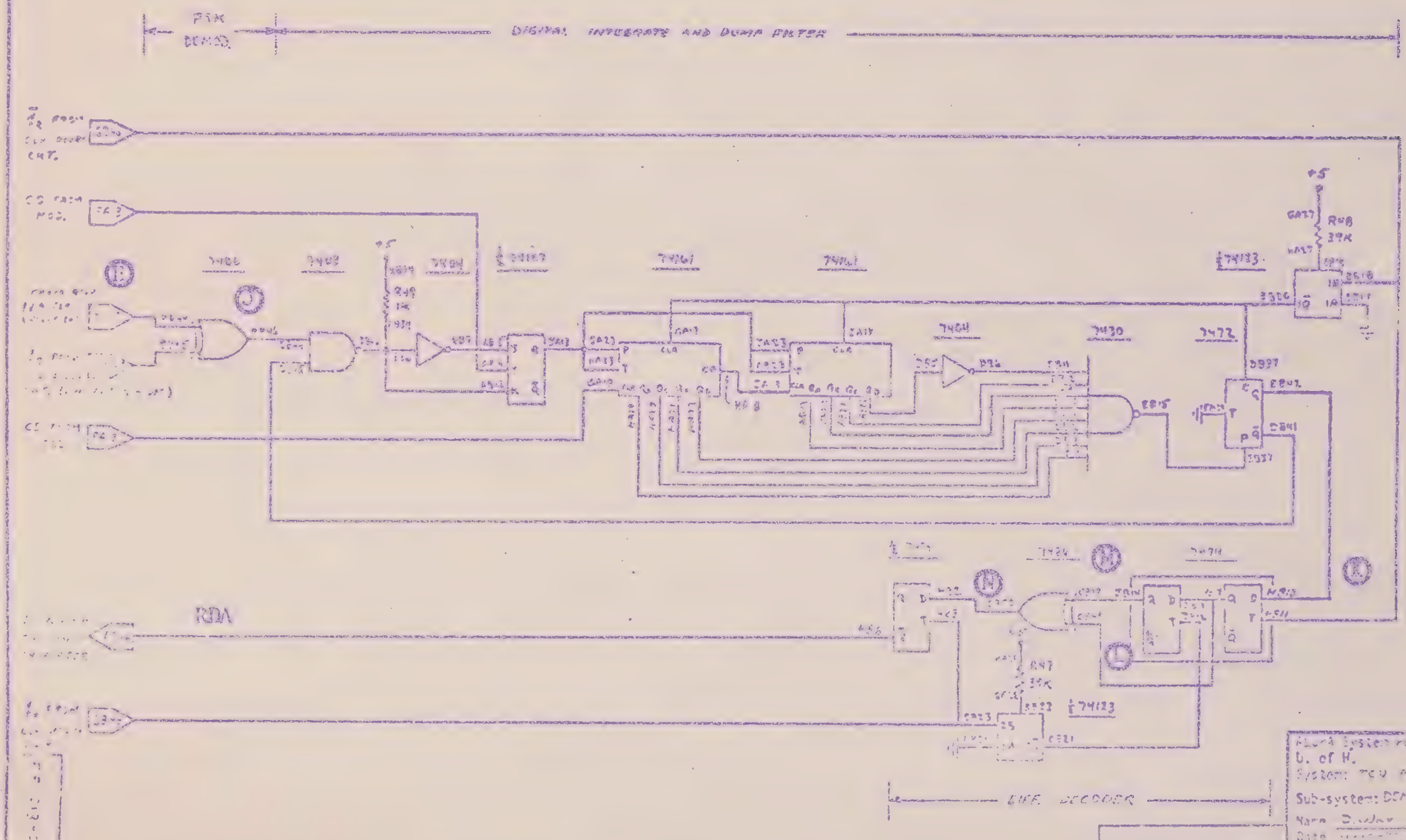

| NO. | DESCRIPTION | DATE | APPD |
|---|---|---|---|
| 1 | CHANGED AMPLIFIER TO 1ST LIMITER; DELETED R36 AND C30; CHANGED R35 TO 100K | 7-2-70 | DWW |

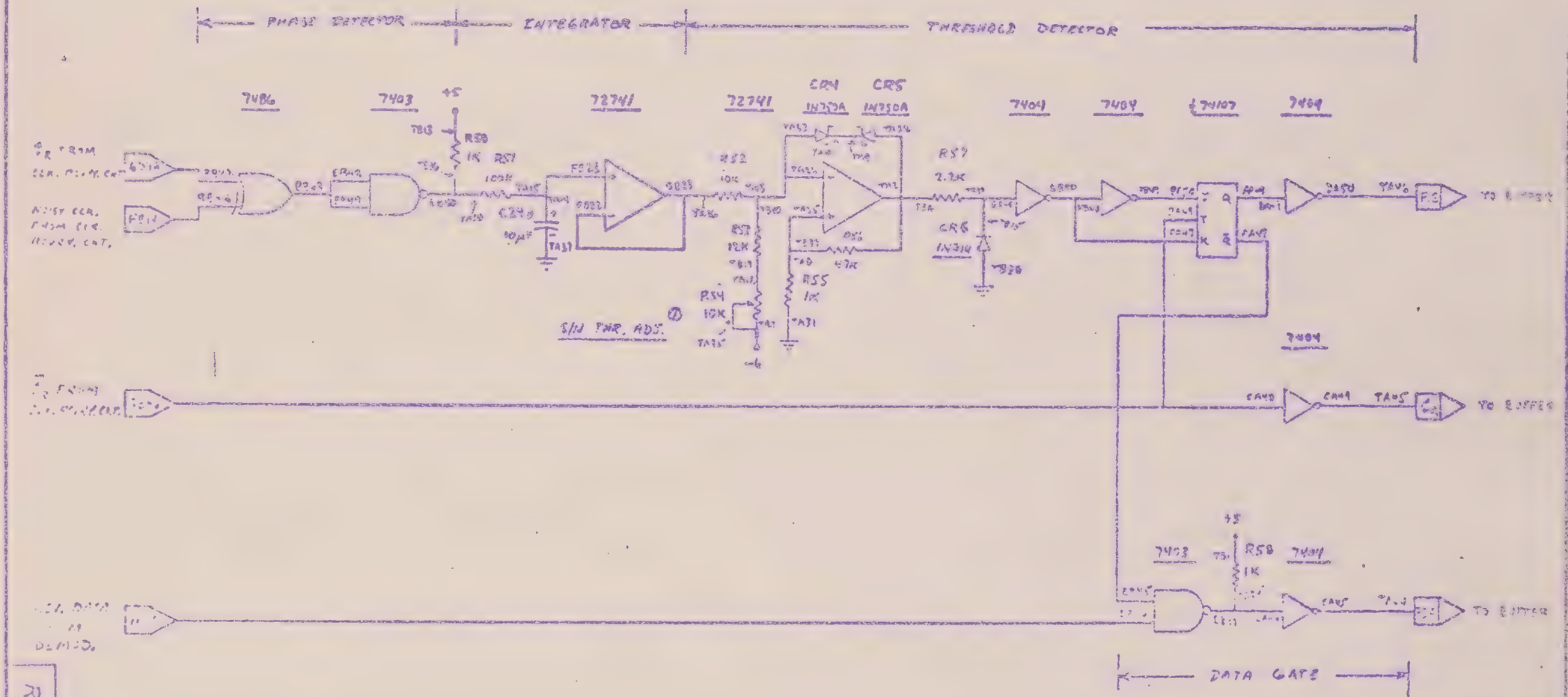
REVISIONS

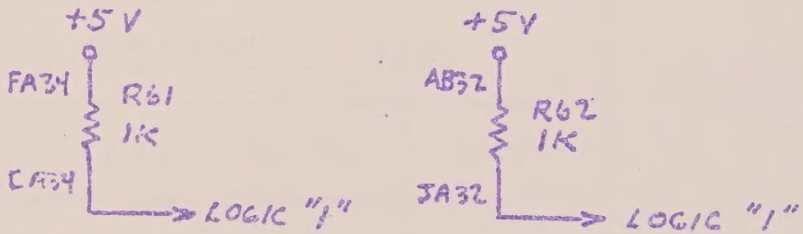
RF 1013-02

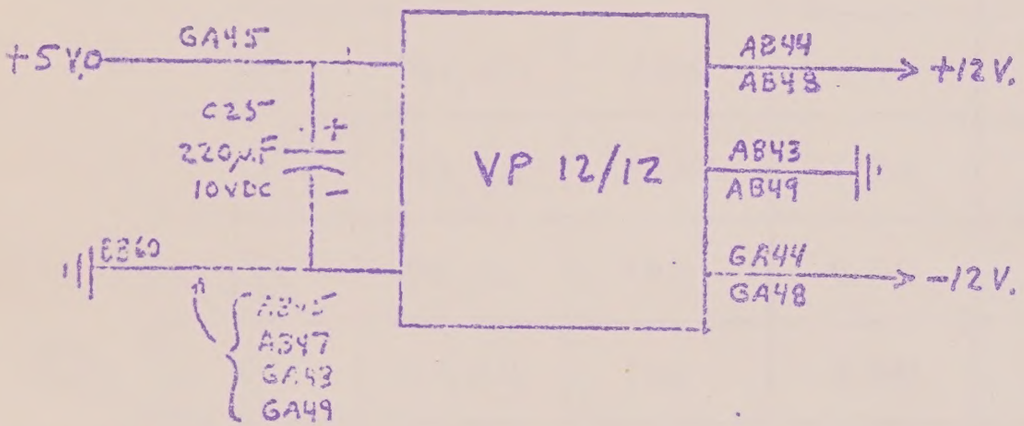
ALOHA System Project
U. of H.
System: TCU MODEM
Sub-system: XMTR-RCVR
Date: 7-1-70
Page ___ of 7


NOISY CLOCK
PROCESSING CKT.
DIGITAL PHASE-LOCKED-LOOP CLOCK RECOVERY CKT.
SEE DATA RATE OPTION TABLE
10 % TOLERANCE
5 % TOLERANCE
RF 1013-03

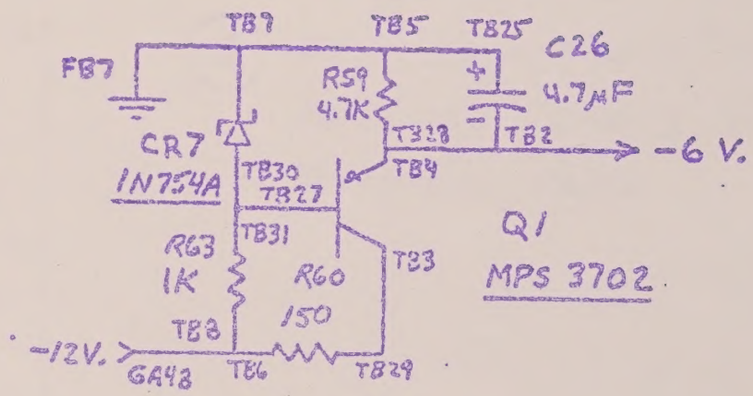

FSK DEMOD.
DIGITAL INTEGRATE AND DUMP FILTER
+5
R=8 39K
74123
74LS123
74H74
74H30
74H04
74LS04
74H00
74H03
74LS08
74LS32
74LS00
74LS74
74H72
74H73
74H51
74H11
RDA
BIT SYNC
LINE DECODER
RF1013-04


PHASE DETECTOR
INTEGRATOR
THRESHOLD DETECTOR
7486
7403
+5
7474
7474
CRN
CRS
7404
7404
74107
7404
R58
1K
R57
100K
C29
10μF
R52
10K
R54
10K
S/N THR. ADJ.
R55
1K
R59
2.2K
CR6
IN916
R56
47K
7404
7403
+5
R58
1K
7404
DATA GATE
* — 10% TOLERANCE
RF1013-05



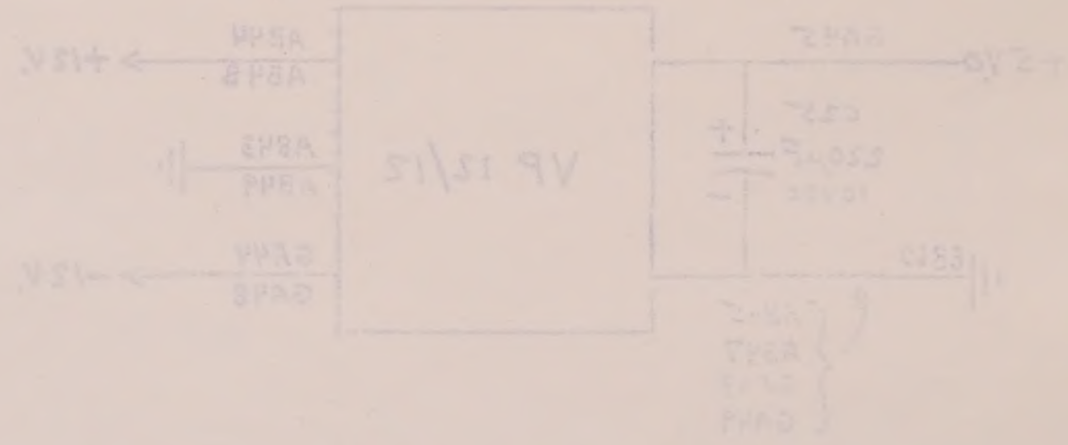




± 12 VOLT SUPPLY




-6 VOLT SUPPLY

RF 1013-06



## DATA RATE OPTION TABLE

| SYMBOL | PARAMETER | 9.6 KBS | 24 KBS | UNIT |
|---|---|---|---|---|
| 1 | FREQUENCY | 9.8304 | 6.1440 | MHz |
| 2 (3) | JUMPER PIN NO. | NONE | EA1 | —— |
| 3 (3) | JUMPER PIN NO. | NONE | FA6 | —— |
| 4 | R1, R2 | 10K | 4.7K | OHMS |
| 5 | R3, R4 | 10K | 4.7K | OHMS |
| 6 | R5, R6 | 10K | 4.7K | OHMS |
| 7 (1) | R7, R8 | 10K | 4.7K | OHMS |
| 8 | C1 | 0.025 | 0.01 | μF |
| 9 | C2 | 0.025 | 0.01 | μF |
| 10 | C3 | 250 | 100 | pF |

NOTES:

(1) ALL RESISTORS ARE $\frac{1}{4}$ WATT, 5% TOLERANCE

(2) CAPACITORS NOTED WITH * ARE 10% TOLERANCE
** ARE 5% TOLERANCE

(3) FOR 24 KBS DATA RATE, REPLACE 74H73 WITH JUMPER PLUG

| NO. | DESCRIPTION | DATE | APP'D. |
|---|---|---|---|
| 1 | CHANGED R7, R8 FROM 20K TO 10K FOR 9.6 KBS RATE 9.1K TO 4.7K FOR 24 KBS RATE | 7-25-73 | DWW |

REVISIONS

RF1013-07

| SYMBOL | PARAMETER | 56 KBS | 24 KBS | UNIT |
|---|---|---|---|---|
| 1 | RESISTOR | 1.820K | 6.49K | OHMS |
| 2 | JUMPER PIN NO. | NONE | EXT | — |
| 3 | JUMPER PIN NO. | NONE | PAR | — |
| 4 | R1, R2 | 10K | 4.75K | OHMS |
| 5 | R3, R4 | 10K | 4.75K | OHMS |
| 6 | R5, R6 | 10K | 4.75K | OHMS |
| 7 | R7, R8 | 10K | 4.75K | OHMS |
| 8 | C1 | 0.375 | 0.01 | MF |
| 9 | C2 | 0.045 | 0.01 | MF |
| 10 | C3 | 250 | 100 | PF |

DATA RATE OPTION TABLE

NOTES:

1. ALL RESISTORS ARE ¼ WATT 5% TOLERANCE
2. CERAMIC DISCS NOTED WITH * ARE 10% TOLERANCE ** ARE 5% TOLERANCE
3. FOR 24KBS DATA RATE, REMOVE JUMPER PLUG

| NO. | DESCRIPTION | DATE |
|---|---|---|
| 1 | CHANGED R7,R8 FROM 10K TO 10K FOR 9.6 KBS RATE 4.75K TO 4.75K FOR 24 KBS RATE | 4-5-73 |

REVISIONS

RF-1013-02